CANVent

Canadian Alternatives in Noninvasive Ventilation

Health Professional Info

Mechanical Insufflation-Exsufflation (MI-E)

What is MI-E?

The MI-E is a mechanical device that simulates a cough and allows for noninvasive airway clearance. The MI-E applies positive pressure by mask, mouth-piece, or tracheostomy connector inflating both lungs evenly. Positive pressure is followed by a rapid shift to a negative pressure to generate a consistent PCF of 300-600 L/min.

Who benefits from MI-E?

Individuals with weak inspiratory and expiratory muscles unable to achieve an effective Peak Cough Flow (PCF) of 270 L/min using lung volume recruitment (LVR) with or without manually assisted cough (MAC) usually benefit from routine use of the MI-E. Weak inspiratory and expiratory muscles are associated with neuromuscular diseases (e.g., amyotrophic lateral sclerosis, muscular dystrophy, post-polio syndrome), spinal cord injury or muscular skeletal conditions (e.g., kyphoscoliosis). The individual must be alert, cooperative and able to communicate.

Why would you perform MI-E?

The use of MI-E will increase cough efficacy for individuals who are unable to achieve PCFs > 270 L/min with LVR with or without MAC particularly during infection.

The MI-E:

- Provides more even inflation and clearance for both lungs;
- Usually results in an increase in oxygen saturation;
- Is often preferred by the individual to traditional suctioning;
- Limits damage to the tracheal wall compared to suctioning;
- Minimizes proliferation of secretions; and
- Can be used as a LVR tool to increase lung volume, increase mechanical compliance thoracic range of motion, and decrease atelectasis.

When do you perform MI-E?

The use of the MI-E is recommended for at least 2-3 therapy sessions per day and as often as required for secretion clearance, mucus-induced oxygen desaturations, and chest infections. Each therapy session should include 3-5 treatments with 3-5 insufflation-exsufflation cycles. Short rest periods between sessions will avoid hyperventilation.

MI-E is best performed before meals and at bedtime if combined with MAC to minimize risk of refluxed gastric content.

MI-E with MAC usually results an improved PCF of up to 20%.

When do you NOT perform MI-E?

The use of the MI-E is not recommended in the presence of hemoptysis, pneumothorax, recent or current barotrauma, bullous emphysema, nausea or vomiting, or previous adverse effects with MI-E.

Traditional suctioning techniques should be used for individuals with impaired consciousness and or inability to communicate.

When do you perform MI-E with caution?

The use of the MI-E should be discontinued if chest pain or dyspnea develops as new symptoms.

Monitor arrhythmias and oxygen saturation in individuals known to have cardiac instability. Bradycardia may occur in response to MI-E similarly to tracheal suction particularly in individuals with spinal shock as a result of spinal cord injury. Bradycardia can be prevented by provision of adequate oxygenation prior to therapy.

For individuals with low vital capacity who do not routinely receive maximum insufflations, high MI-E insufflation pressures can cause rib cage muscle discomfort. This can be alleviated by gradually increasing MI-E pressures to therapeutic levels.

Where would you perform MI-E?

The use of the MI-E is possible in any clinical or home setting with an alert, cooperative individual able to communicate.

How would you perform MI-E?

The following describes the MI-E's most common settings. Evidence-based information for new MI-E modalities such as oscillations is limited and hence will not be discussed in this document.

Manual or automatic MODE

- The MI-E can be cycled manually or automatically.
- To initiate manual therapy a foot pedal may be available to allow hands-free MI-E operation.
- Manual cycling allows for provider-individual coordination of the insufflation-exsufflation phase.
- The automatic mode allows caregivers/individuals to preset insufflation-exsufflation time and pause between breathing cycles. The pause is usually not required, especially if it does not simulate natural breathing patterns.

Insufflation-exsufflation time SETTING

- The insufflation time should be sustained as long as the chest rises.
    - 1.5 to 3 seconds (adults)
    - 0.5 to 1.5 seconds (children)
- The exsufflation time should be limited to the chest fall time
    - 1.5 to 3 seconds (adults)
    - 0.5 to 1.5 seconds (children)

Insufflation-exsufflation pressure SETTING

- The usual therapeutic pressures are + 40 / - 40 cmH_2O.
- The minimal effective pressures are + 30 / - 30 cmH_2O.

Inhale flow SETTING

- Adjust inhale flow as per individual's comfort.
- A low inhale flow may be preferable for individuals with flaccid airways.

How would you apply MI-E therapy in manual mode?

1. Use of appropriate personal protective equipment must be assessed prior to the application of the MI-E. The MI-E may generate droplets with increased exposure to respiratory pathogens.
2. Always verify insufflation-exsufflation pressures before starting each session by occluding the tubing distal to the MI-E with a gloved hand.
3. Establish a signal that will identify the caregiver if the individual wishes to terminate therapy.
4. Coordinate the application of the interface with the individual's breathing pattern.
5. Apply interface securely and minimize leaks.
6. Shift toggle switch to (+) as the individual is breathing IN.
7. Hold inspiratory pressure for up to 3 seconds, as long as the individual's chest continues to rise (adults).
8. Verbalize your action by saying "IN-IN-IN".
9. Rapidly slide toggle control lever (or foot pedal) from (+) to (-) pressure.
10. Simultaneously prompt the individual to attempt a single "COUGH".
11. Hold exsufflation phase for 1.5 to 2.5 seconds (adults).
12. Minimize pause between cycles and repeat insufflation-exsufflation up to 3-5 times.
13. At the end of treatment, remove the interface while maintaining the (-) pressure. This allows for secretions to clear from the airway. Secretions may end up in the mouth or interface.
14. Allow the individual to rest for 30 seconds to avoid hyperventilation then resume a new series of insufflation-exsufflation cycles.

How would you apply MI-E therapy in automatic mode?

Refer to the manufacturer's clinical manual when adjusting the automatic mode in keeping with the above recommendations.

Clinical considerations when using the MI-E with an artificial airway?

- Add one or several 6-inch large bore tubing with tracheostomy connectors (universal aerosol connectors fitted securely to the tracheostomy) to the MI-E circuit to help trap secretions. The 6-inch tubing can be discarded if secretions are collected.
- Hold the tubing end like a pencil to allow for easy disconnection.
- It is best to perform MI-E with an INFLATED cuff to minimize leak and enable the chest to reach therapeutic pressures.
- To allow secretions to drop from above to below the cuff, briefly deflate the cuff prior to therapy. Secretions will be expelled through the tracheostomy once MI-E therapy begins.
- Use of the MI-E with a CUFFLESS tracheostomy is possible. The tracheostomy stoma must be tight around the tracheostomy and the individual must have good control of their vocal cords.
- The MI-E may be applied through the tracheostomy opening or by facemask. Whichever interface is used always ensure therapeutic pressures are reached.

- Secretions remaining in the artificial airway should be suctioned out or the inner cannula cleaned or changed.
- Always try to AVOID DEEP SUCTIONING and repeat MI-E if necessary.
- Intubated or tracheostomized individuals may require higher pressures due to the smaller diameter of the artificial airway.

Clinical considerations when introducing MI-E with first time users?

- It is best to introduce MI-E with low pressures and sequentially; insufflation only, and then add exsufflation.
- Begin with pressures of +15 / -15 cmH_2O. Another starting point may be 5 cmH_2O greater than the individual's spontaneous maximum inspiratory pressure (MIP) or 5 cmH_2O greater than the ventilator peak airway inspiratory pressure.
- Continue to observe the individual's acclimatization to therapy and ensure adequate chest insufflation-exsufflation.
- Gradually increase the pressures for optimal therapy; usually + 40 / - 40 cmH_2O.
- A common problem with MI-E is the continued use of low pressures. Individuals and caregivers often become discouraged because they see very little benefit if low pressures are used compared to the time and energy required to perform the MI-E.
- Unequal pressures + 30 / - 35 cmH_2O may be prescribed to MAXIMIZE the exsufflation while MINIMIZING the stretch to the intercostal muscles during insufflation. This is particularly useful for first time users who are at risk of developing respiratory infections and who require maximum exsufflation.

Other MI-E clinical considerations

- Blood streaked sputum collected as a result of the MI-E likely originates from the bronchial wall site of a mucus plug. This should not cause concern.
- A single MI-E cycle (in-out) may be more effective than a sequence of cycles for individuals with significant loss of glottic control.
- MI-E can also be used to provide daily chest expansion using positive pressure only.
- ALS individuals with advance bulbar weakness may not benefit from MI-E.
- MI-E can cause early closure of the airways in conditions such as chronic obstructive pulmonary disease, cystic fibrosis and bronchiectasis.
- Other physiologic effects of MI-E are minimal and include:
    - Increase of peripheral venous pressures by 5.8 mmHg during MI-E exsufflation; which is equivalent to about 1/3 of the increase observed in normal coughing;
    - Increase of BP by an average of 8 mmHg during systole and 4 mmHg during diastole;
    - Intragastric pressure may also increase by 26 mmHg with MI-E compared to 85 mmHg during normal coughing.

Glossary

LVR	Lung Volume Recruitment	MIC	Maximum Insufflation Capacity
MAC	Manually Assisted Cough	MIP	Maximum Inspiratory Pressure
MI-E	Mechanical Insufflation-Exsufflation	PCF	Peak Cough Flow

